Claims

We claim:

1. A digital receiver for detecting symbols in a baseband signal in a DS-CDMA network, comprising:

a plurality of spaced apart antennas;

a time-frequency rake receiver connected to each of the antennas;

an interference canceller connected to each output of each of the rake receiver, each interference canceller producing a contributing symbol in parallel; and

a diversity combiner to determine a decision symbol from the plurality of contributing symbols, the decision symbol corresponding to the baseband signal.

2. The receiver of claim 1 wherein the antennas are spaced about three to five times the wavelength of the baseband signals.

3. The receiver of claim 1 wherein each rake receiver includes a plurality of rake fingers, and wherein the baseband signal received at each antenna is modulated to a plurality of different frequencies, one frequency for each of the plurality of rake fingers.

4. The receiver of claim 1 wherein each rake finger has a different time delay.

5. The receiver of claim 4 wherein a symbol time is T_b, and wherein the output of each rake finger is sampled at symbol times T_b to form a down-sampled signal for each interference canceller.

6. The receiver of claim 5 wherein each interference canceller further comprises:

an adaptive filter to receive a real part ($Re(*)$) of the down-sample signal $u_{i,j}$, the adaptive filter including a plurality of taps, each tap having a tap weight, and wherein the tap weights are update every symbol time T_b according to a least mean square process.

7. The receiver of claim 6 wherein a sign of an output of the adaptive filter is a reference signal subtracted by the adaptive filter.

8. The receiver of claim 7 wherein the reference signal is a training signal during an initial training stage.

9. The receiver of claim 8 wherein the training signal is a predetermined random sequence generated by using a polynomial known to the receiver.

10. The receiver of claim 1 wherein the outputs of each interference canceller include an error signal and one contributing symbol.

11. The receiver of claim 1 wherein the diversity combiner combines all contributing $C_{i,j}$ with different weights according to the error signals $E_{i,j}$, and the decision symbol d 109 is defined by

$$d = \operatorname{sgn}\{\sum_{i=1}^{M}\sum_{j=1}^{N}\alpha_{i,j}C_{i,j}\},$$

where α_i is a weighting factor

$$\alpha_{i,j} = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}E_{i,j}}{E_{i,j}},$$

where M is the number of antennas, and $(N-1)$ is the number of frequency shifts at each antenna.

12. The receiver of claim 6 wherein a transmitter periodically transmits the training signal to establish initial tap weights for adaptive filter of each interference canceller.

13. The receiver of claim 10 wherein a frequency offset is estimated by identifying a location of the decision symbols with the smallest error signal.

14. The receiver in claim 10 wherein the decision signal has a smallest error signal.

15. The receiver in claim 10 wherein the decision signal has a highest signal-to-noise ratio.

16. A method for detecting symbols in a baseband signal in a DS-CDMA network, comprising:

receiving the baseband signal by a plurality of spaced apart antennas;

frequency shifting the baseband signal received at each antenna;

down sampling each frequency shifted baseband signal at sample times *Tb*,

adaptively filtering each down sampled signal to produce a contributing symbols in parallel; and

combining the plurality of contributing symbols to determine a decision symbol corresponding to the baseband signal.